A Summary Trigger Unit for the ALICE Electromagnetic Calorimeters

筑波大学
University of Tsukuba

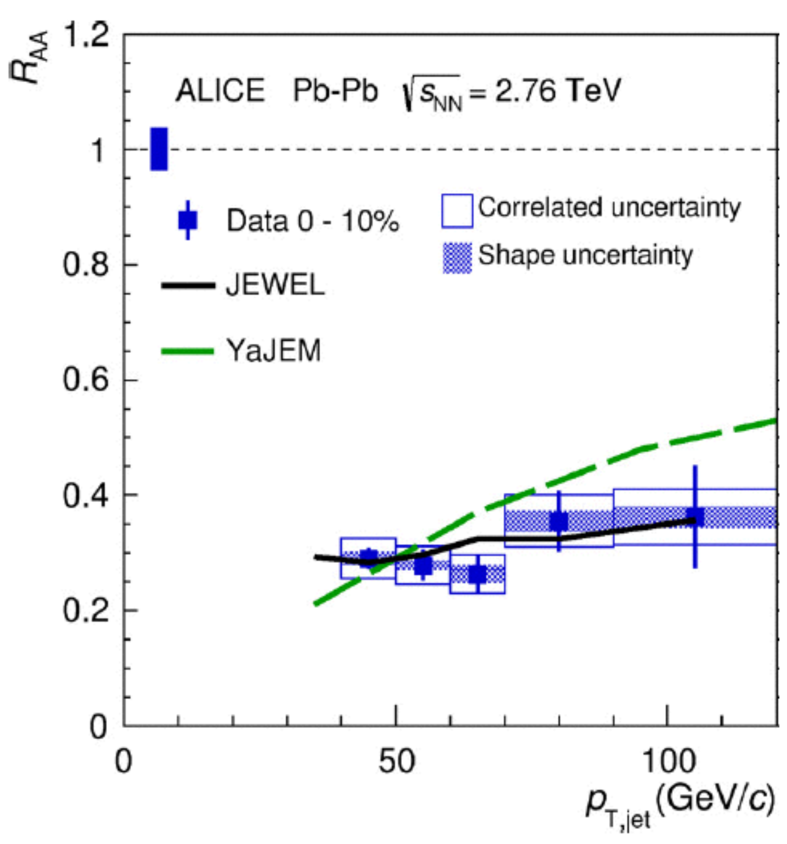
Olivier Bourrion[1)], Tatsuya Chujo[2)], Rachid Guernane[1)], Ritsuya Hosokawa[2)], Hiroki Yokoyama[1,2)] for the ALICE Collaboration

1) Laboratoire de Physique Subatomique et de Cosmologie de Grenoble,
2) University of Tsukuba, Japan

LPSC Grenoble
Laboratoire de Physique Subatomique et de Cosmologie

The STU, a FPGA-based embedded electronic device implementing the ALICE Level-1 (L1) calorimeter triggers, has demonstrated during LHC Run 1, efficient real-time selection of events with high transverse momentum jets and photons. During the recent LHC Long Shutdown 1, the ALICE calorimetry system was upgraded with DCal, a second arm situated back-to-back in azimuth to EMCal and surrounding PHOS. Taking advantage of this two-arm setup, and through the flexibility and scalability of STU hardware design, ALICE has decided to extend the use of STU to both DCal and PHOS calorimeters. A new L1 jet trigger algorithm was then proposed for Pb-Pb data taking, aggregating DCal and PHOS regions to estimate on an event-by-event basis, an energy density used to correct EMCal jet patches from soft background contamination, and vice versa. The ALICE STUs are now under commissioning since summer 2015 at CERN with the aim to have them routinely included in data taking.

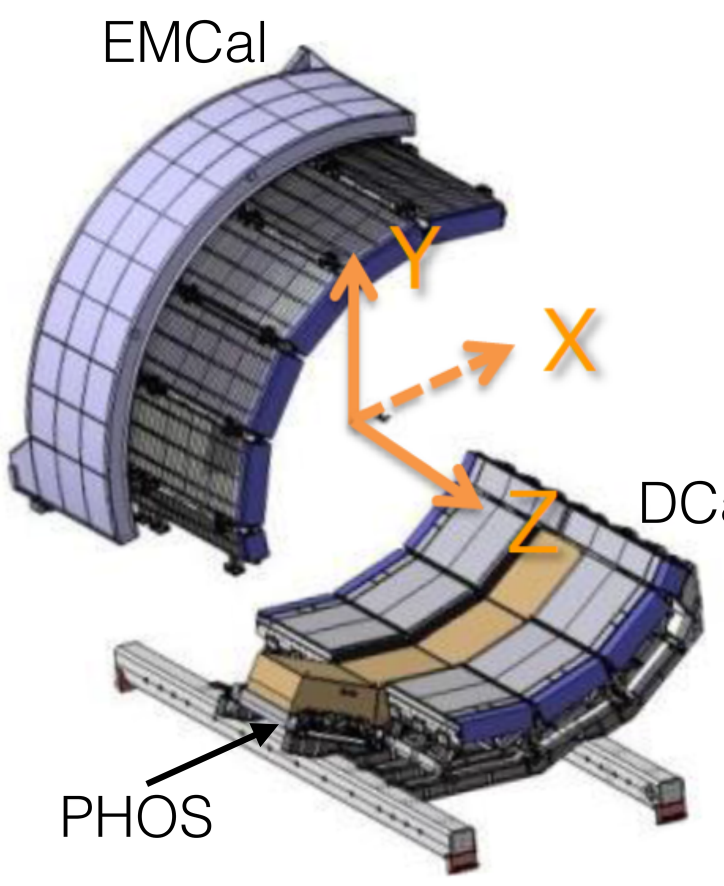
Physics Motivation



Jet nuclear modification factor R_{AA} for the 10% most central collisions from ALICE. R_{AA} measures deviations in yields from a simple superpositions of incoherent proton-proton collisions.[1]

The ALICE experiment is dedicated to the study of Quark Gluon Plasma (QGP). Jets are recognized as a valuable probe of the QGP since their yield is expected to be modified by the QGP formation. QGP indeed induces partonic energy loss which strongly reflects its properties. As a result of medium induced energy loss, the observed jet energy is reduced (Jet Quenching), and the jet shape is modified. We can assess QGP effects quantitatively through comparison between nucleus-nucleus collisions and proton-proton collisions.

ALICE Electromagnetic Calorimeters

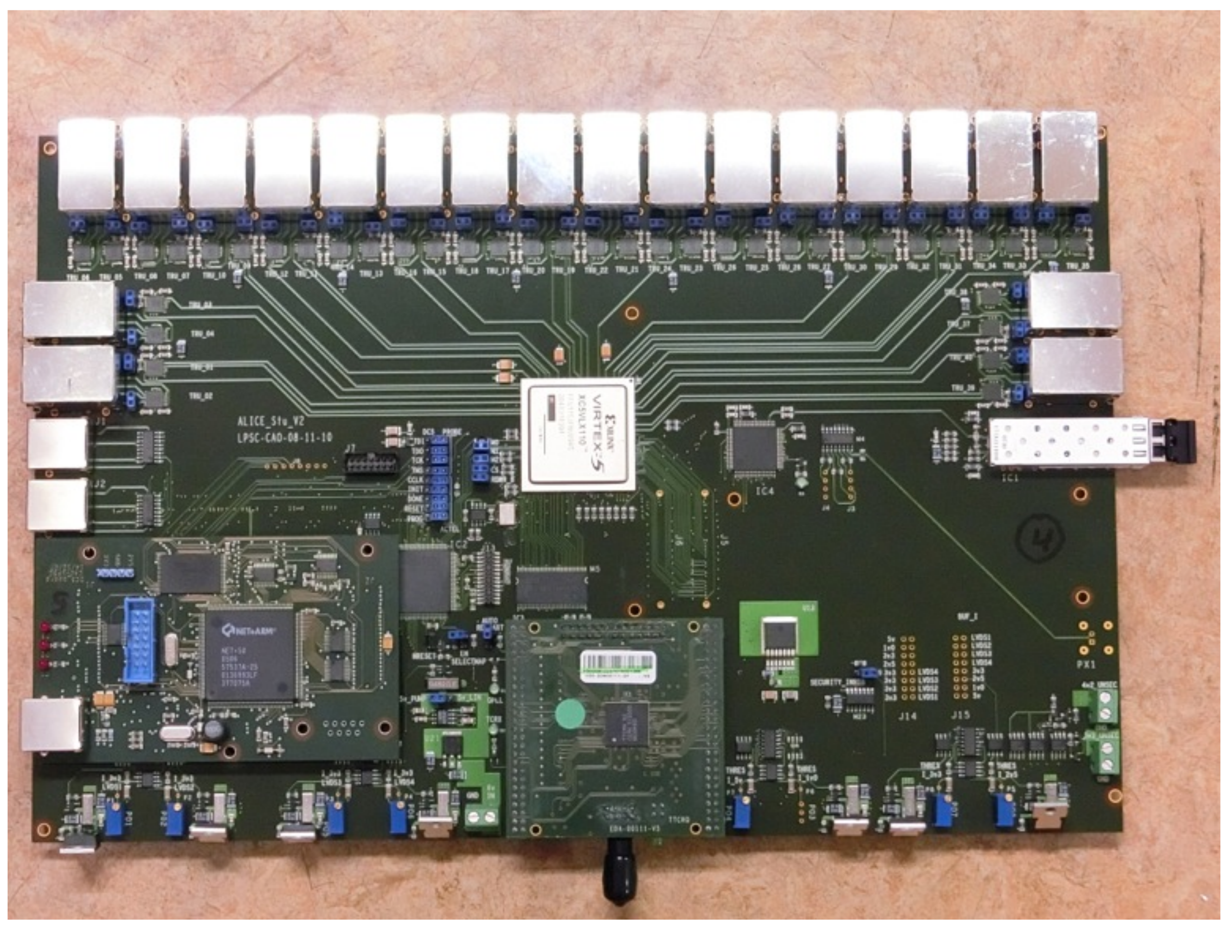


Calorimeters structure in ALICE detector system

The electromagnetic calorimeters (EMCal, DCal, and PHOS) significantly enhance ALICE capabilities to measure high-pt processes at LHC Run 2. These detectors are able to provide fast triggering, precise energy measurement, and efficient identification of photons and electrons.

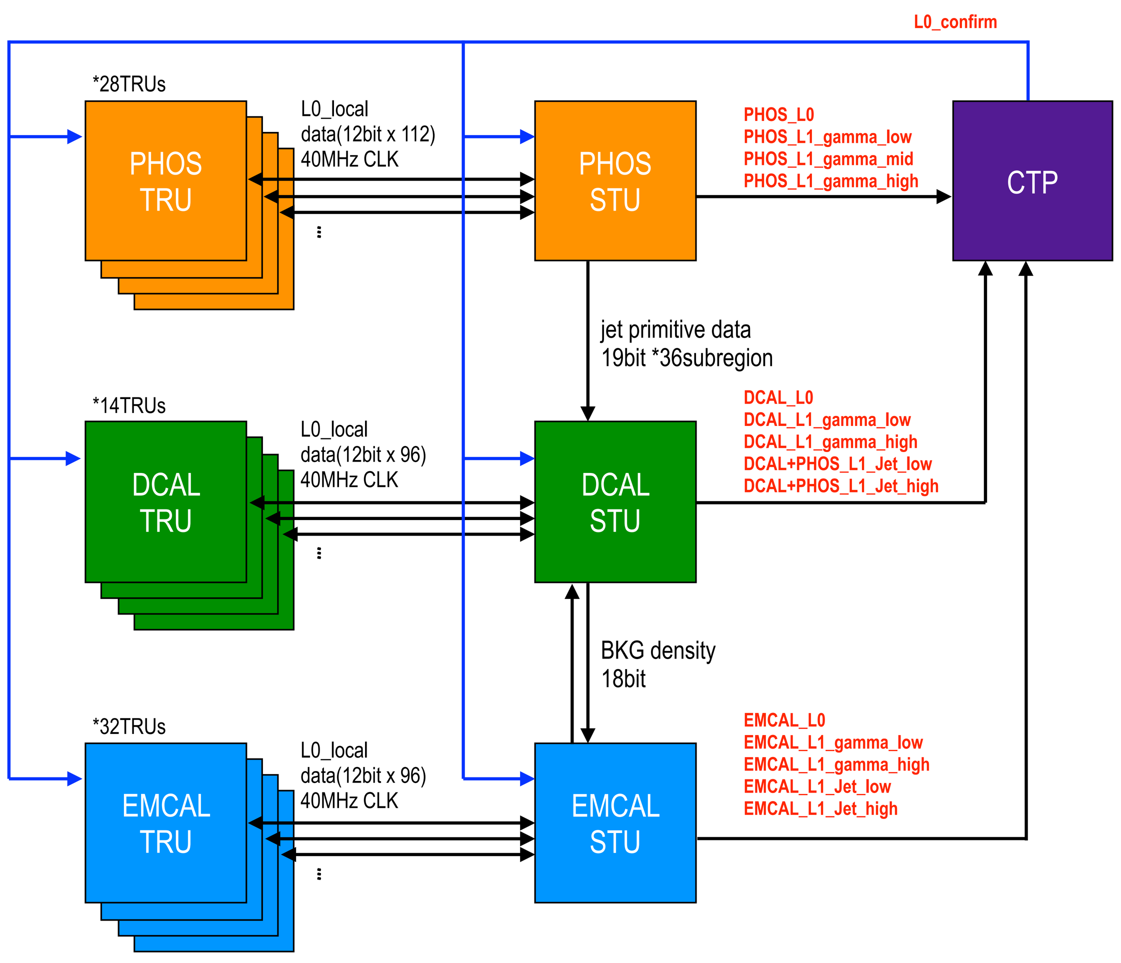
- EMCal and DCal
  - $|\eta|<0.7$, $\Delta\varphi=107°$ (EMCal)
  - $0.22<|\eta|<0.7$, $\Delta\varphi=67°$ (DCal)
  - Pb-Scintillator sandwich type calorimeter
  - 12288 (EMCal), 5376 (DCal) towers
  - tower size: 6.0x6.0 cm^2
- PHOS
  - $|\eta|<0.12$, $\Delta\varphi=70°$
  - lead-tungstate crystal (PWO) based
  - 12544 crystals
  - crystal size: 2.2x2.2 cm^2

Summary Trigger Unit (STU)



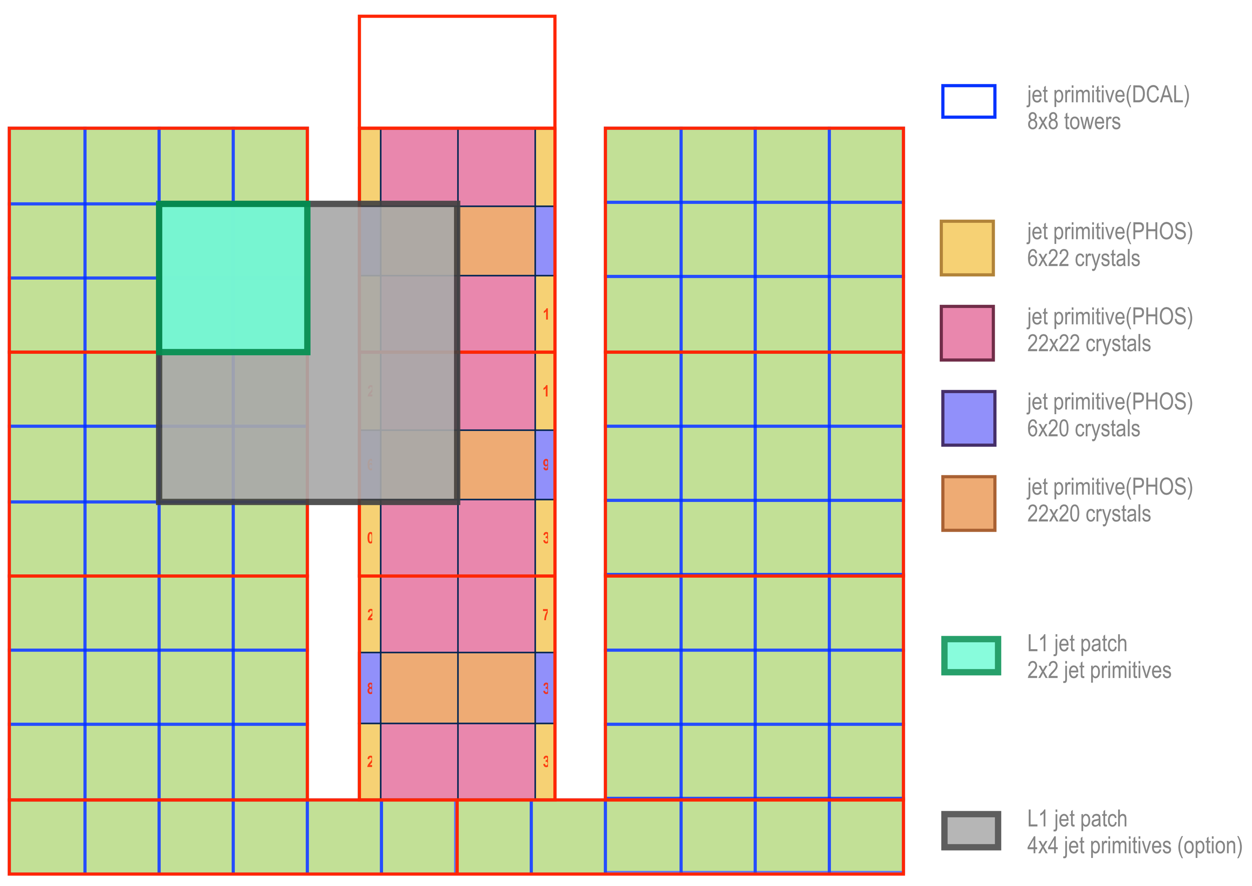
The Summary Trigger Unit (STU) computes Level-1 Jet and Photon triggers. The trigger algorithm is implemented on an FPGA (Xilinx Vertex5) and it can be configured remotely. STU and Trigger Region Unit (responsible for L0 triggers) are connected with 120MHz serial links while STUs communicate through 80MHz serial links. This last connection is needed to compute the Jet trigger.

L1 data transmitting



Each STU receives module (2x2 towers) amplitudes from the Trigger Region Unit (TRU) and applies L1 algorithms to generate L1-gamma and L1-Jet signals. For L1-Jet, PHOS data are shared with DCal at STU level due to the large Jet patch size. Also DCal+PHOS (EMCal) estimated background density data will be transmitted to EMCal (DCal) for Jet background subtraction. The Central Trigger Processor (CTP) collects all trigger output signals from STUs and generates the global trigger decision for all the ALICE detectors.

L1-algorithm



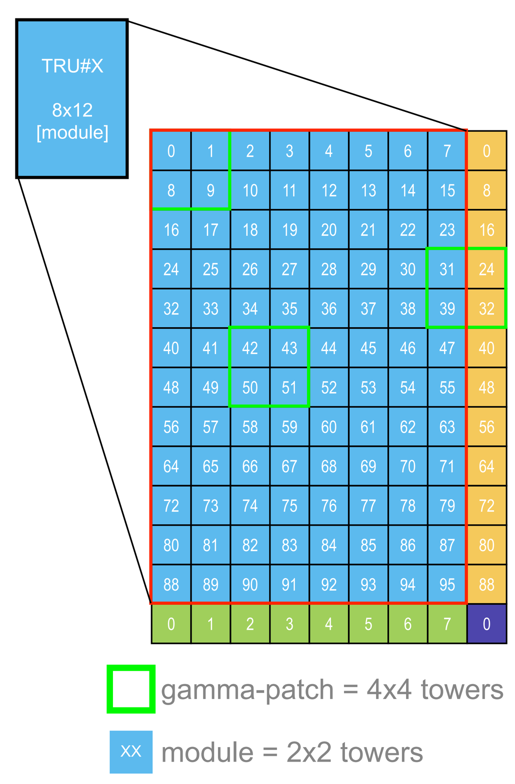
L1-Jet trigger patch for DCAL and PHOS side

- L1-gamma algorithm

This algorithm is based on module (2x2 towers) amplitudes. The sum of module amplitudes in a sliding gamma-patch (2x2 modules) are calculated and compared with threshold defined by the V0-detector. The on-the-fly calculation is done during serial transmission between TRU and STU.

- L1-Jet algorithm

This algorithm is based on jet-primitive (8x8 towers) amplitudes.The sliding Jet-patch (2x2 or 4x4 jet-primitives) amplitudes and background patch (2x2 jet-primitives) amplitudes are calculated. The computed median value from background patches is subtracted by jet patches of the opposite side detector and compared to a constant threshold set by DCS slow control. This background subtraction method allows to reduce the impact of background fluctuations in heavy-ion collisions. The background subtraction will be applied only at heavy-ion collisions. The constant threshold will be used in other system.



L1-gamma trigger patch

[1] The ALICE collaboration, J.Adam et al., Measurement of jet suppression in central Pb-Pb collisions at √sNN = 2.76 TeV, Physics Letters B 746 (2015) 1–14